UDC 631.95:631.15
MILIUTENKO T.B., j.r.o.
Institute of agricultural microbiology and agricultural production of NAAS
e-mail: liashkot@gmail.com

FERTILIZATION OF GRAIN MAIZE GROWING ON SOD -PODZOLIC SOILS

The efficacy of using of 40 t/ha manure, intermediate green manure (blue lupine - lupinus angustifolius), fertilizers ($N_{90}P_{90}K_{90}$) and their combination with green manure were studied in conditions of field stationary and lysimeter experiments in growing grain maize on sod-podzolic soils. Organic and mineral fertilization contributed the formation of the highest yield of grain maize in the experiment. Thus a loss of compounds of the nutrients was significantly limited beyond the root layer soil compared to using only fertilizers.
Keywords: *sod-podzolic soils, grain maize, green manure, crop, fertilizer, fertilizing system*

Introduction. It is known that the yield of crops is formed under the influence of a complex of abiotic and biotic factors, among which the factor of fertilization is a significant one [3].

In recent years, modern agricultural market holds a steady demand for grain maize. Producers of the state, having the possibility to sell grown products, significantly expand crop area for this agricultural crop. However, the absence of balanced fertilization of grain maize, especially in Polissia region, where the domination of sod-podzolic soils in the production conditions allows using only for 45-65% the potential productivity of modern hybrid. The most valuable property of the soil – fertility suffers the negative impact on these conditions [3, 6]. Agrochemical examination of sod - podzolic soils suggests that the balance of humus over large areas remains negative - 151-203 kg/ha [5]. This is despite the fact that recently a significant part of the subsistence harvest of grain maize has been returning to the soil. Every hectare of arable land annually loses 333-376 kg of humus [5]. Tenants of the land shares neglect the requirement to preserve the environment, getting the harvest at all costs.

To create 1 ton of grain and the appropriate number of stem weight maize requires $N_{18-25}R_{8-12}K_{16-24}$ [3, 7]. The recommended for Polissia region dose of fertilizers for maize grain $N_{90}P_{90}K_{90}$ on a background of 40 t/ha cattle manure [3, 5].

In fact, each hectare receives 111 kg of mineral nourishment and 0.5 t / ha of organic fertilizer [5].

The real alternative to the current system of fertilization in the absence of sufficient manure would be an introduction of a green manuring by a combination of chemical fertilizers.

Green manuring as an agrotechnical practice has a long history of studying at Chernihiv Institute of Agroindustrial Production NAAS and is recommended for use [2]. In terms of biologization of the agriculture the technology provides growing of blue lupine in the intermediate crops after winter and spring crops. Using green manures at the sod- podzolic soils has the opportunity to replace making 30 t/ha manure, reduce vertical water runoff for 25-30% and reduce the loss of compound nutrients from the soil and fertilizer: calcium – by 80-105 kg/ha, nitrogen – by 46-60 kg/ha, magnesium – by 18-20 kg/ha, water-soluble humus – by 10-16 kg/ha, and better use of soil and climatic potential areas of the Polissia region[1].

In this context, the aim of our work is to study the efficacy of green manure - mineral fertilization system over traditional methods of fertilization of corn.

Materials and methods. The study was conducted at the Institute of Agricultural Microbiology and Agricultural Production NAAS. Field research stationary was placed on sod-podzolic dusty-sandy soil, which has the following agrochemical characteristics: pH_{KCl} - 4.9, humus content - 1.1%, moving phosphates - 179.0 mg/kg of soil, exchanging potassium – 70-90 mg/kg of soil, hydrolytic acidity - 2.8 mg-eqv per 100 g of soil. Soil conditions are typical for the the Polissia zone [2].

Grain maize was grown under different fertilization systems: without fertilizer (control), green manure, $N_{90}P_{90}K_{90}$, green manure + $N_{90}P_{90}K_{90}$, manure 40 t/ha.

Cattle manure was applied in the autumn. Lupinus angustifolius, as an intermediate green manure, was sown after the harvest of winter rye in early August.

The evaluation of the state of the crops and some agrochemical indices were studied according to the phases of maize plants: 6-8 leaves, blossoms, filling of grain.

In addition to the stationary field experiments, studies were performed under conditions of lysimeter installation of soil that has similar characteristics to those described above. Compounds studied loss of nutrients, humus and moisture during the growing season. The processing of results of experiments was performed by the method of B.A. Dospekhov [4].

Results and discussion. As it is known, the providing of plants with mineral forms of nitrogen from the soil can be done in two ways: making fertilizer and as a result of bacillus subtilis/mycoides/megatherium, that carry out the mineralization of organic matter. Further ammonium form of nitrogen oxidized to nitrate, which is the main source of nitrogen nutrition of plants [5, 6].

We found the optimal values of nitrate nitrogen content in the soil in the initial period of the growing season of maize with complete mineral fertilization and green manure – blue lupine. In phases of flowering and grain filling the favorable nitrogen regime was marked by variant with manure, which can be explained by intense mineralization of organic fertilizer.

The content of water-soluble phosphorus is particularly necessary during grain filling, because it determines largely the mass of grains and grain quality [7]. It is worth to indicate, that phosphorus was not limiting in the experiment because the soil contains sufficient amounts of its compounds. However, the growing of lupine for green manure contributed to a significant growth of mobile P_2O_5 content compared with the control - in 0,8-1,9 mg/100g of soil. Mineral fertilization system contributed to its optimization period from germination to flowering phase, manure - in blooming and filling grain phases.

The content of potassium within the physiological feasibility is important practically throughout the whole period of intensive growth and the formation of the mass of plants in general. It can also determine the efficiency of fertilization of corn nitrogen and phosphorus fertilizers [7]. For its content in the soil 6-8 mg per 100 g of potassium fertilizers increase the rate at 1.2-2.0 mg/100 g throughout the growing season, and in blooming and filling grain phases (1,8-3,2 mg/100 g). Notable changes in the potassium mode of soil weren`t found.

Parameters that characterize the process of passing on lots of options photosynthesis experiment for different methods of fertilization were analyzed during the experiments. The best indicator is the amount of productive crop leaf area crop of 40 - 50 thousand m^2 (60) for 1 ha [8]. In our experiments these criteria conformed with the sowing of corn in case of using mineral ($N_{90}P_{90}K_{90}$) and green manure - mineral fertilization system (green manure + $N_{90}P_{90}K_{90}$). In terms of surface leaves area options - $N_{90}P_{90}K_{90}$ and green manure + $N_{90}P_{90}K_{90}$ – higher than controls, respectively in 22 and 24%. These variants of the experiment had 29% excess of controls and indicators of photosynthetic capacity of crops.

A good condition of a clean photosynthetic productivity is formation at 1 m^2 of leaves square of 4 - 6 grams of organic compounds during 24 hours [8]. In our experiments, measures of photosynthetic activity of maize plants were highest in conditions of the combination of green manure with chemical fertilizers and cattle manure, which is 14 % higher than in the control (Table 1).

Manure effect on the formation of leaf area can be quite comparable to the effect of green manure. However, the accumulation of dry matter in the application of manure was higher compared to green manure fertilization. So green manure improves the quantitative parameters of photosynthesis, manure – qualitative ones.

In the types of experience with organic fertilizers (green manure + $N_{90}P_{90}K_{90}$) and manure 40 t/ha the higher net photosynthetic productivity was noted in comparison with other variants of fertilization. This case indicates indirectly the ability of the formed agrocenosis to form higher grain yield under the influence of fertilization techniques.

Table 1

Indicators of photosynthetic activity of grain maize plants Influenced by different types of fertilizers

Types of fertilization	Maximum surface area of plant leaf		Photosynthetic potential		Pure productivity of photosynthesis	
	thousands m^2/ha	% before control	mln m^2 d./ha	% before control	g/m^2/ 24h	% before control
No fertilizers (control)	34,0	100	2,4	100	5,6	100
Green manure	38,8	114	2,9	121	5,9	105
$N_{90}P_{90}K_{90}$	41,5	122	3,1	129	6,2	111
Green manure + $N_{90}P_{90}K_{90}$	42,0	124	3,1	129	6,4	114
Manure 40 t/ha	36,0	106	2,7	113	6,4	114
HIP_{05}	0,1		0,1		0,1	

A summary indicator of agricultural productivity is the output of dry matter weight agronomic crop plants: good productivity – 70-80 kg/ha, high one – 100-120 kg/ha, very high – 140-160 kg/ha. [3] Accounting of grain maize harvest leads to the conclusions of the weak influence of only organic fertilizers (manure as well as blue lupine green manure) for the implementation of the productive potential of corn (Table 2). A substantial increase in crop productivity is observed during the fertilization. However, the option of fertilizing maize plants green manure + $N_{90}P_{90}K_{90}$ on the basis of accounting of yield provided the highest gain before the control – at 80 %.

Table 2

The level of grain maize productivity depending on fertilization techniques

Types of fertilization	Productivity, t/ha	Increment to the absolute control	
		t/ha	%
No fertilizers (control)	4,40	-	-
Green manure	4,70	0,30	6,8
$N_{90}P_{90}K_{90}$	7,50	3,10	70,5
Green manure + $N_{90}P_{90}K_{90}$	7,92	3,52	80,0
Manure 40 t/ha	4,70	0,30	6,8
HIP_{05}	0,13	0,13	0,13

Output of 1 kg of active ingredient of fertilizer in their pure effect gives 25.9 kg of grain; in combination of fertilizers and green manure rises to 28.9 kg, which is 12% more than the use of pure mineral food.

Received indicators are explained l due to the results lysimeter experiments. So, on the back of green manure fertilization the loss of compounds of nutrients and moisture was less than in controls. Significant losses compared to the control were observed in the form of the introduction of 40 t/ha manure.

Low rates of loss of food and water precipitation during the growing season of culture were provided by combination of green manure using chemical fertilizers (Table 3).

Concomitant use of green manures and fertilizers contributed to the growth of both: the removal of nutrients increased harvest and temporal binding of soil absorbing complex.

Table 3

Loss of nutrients compounds, humus and moisture during the maize growing season depending on methods of fertilization, kg/ha

Types of fertilization	NO_3	NH_4	P_2O_5	K_2O	CaO	MgO	Humus soluble	Moisture in % of presipitation
Control	40,0	5,6	6,0	5,2	80,2	22,8	24,8	20,0
Green manure	36,1	4,0	3,2	3,1	61,0	18,0	16,0	16,2
$N_{90}P_{60}K_{90}$	56,0	6,8	6,6	6,0	106,0	28,0	26,0	24,0
Green manure + $N_{90}P_{60}K_{90}$	52,0	6,0	5,0	6,0	88,0	20,4	19,0	21,0
Manure, 40 t/ha	64,0	8,8	7,0	8,2	122,0	32,0	31,4	26,0
HIP_{05}	4,5	0,4	0,5	0,6	10,0	7,7	2,1	

Conclusions. Consequently, grain maize productivity in conditions of growing on sod-podzolic soils can increase on 70%-80% by optimizing of fertilization the agriculture crop. Expansion and use the soil areas that are occupied with intermediate green manure crops, making the recommended dose of fertilizers is an effective technique to increase productivity and environmental sustainability of agrocenosis. It is also a reliable way to provide the soil with organic matter, especially in the absence of traditional organic fertilizers - manure.

References

1. Ґудзь В.П. Землеробство / В.П Ґудзь. – К.: Центр учбової літератури, 2010. – 464 с.
2. Мельничук А.О. Післяжнивні сидеральні культури – надійне джерело органічної речовини для покращення родючості ґрунту [Електронний ресурс]. – Режим доступу: http://www agrodovidka.info.
3. Мельник А.І. Агрохімічний стан ґрунтів та застосування добрив у Чернігівській області / Мельник А.І. – Чернігів: [б.в.], 2012. – 92 с.
4. Надь Я. Кукурудза / Янош Надь; ред. В.І. Власов, В.В. Шелепов В.В. та ін. – Вінниця: ФОП Корзун Д.Ю., 2012. – 580 с.
5. Бойко Є.І. Агровиробничі особливості ґрунтів Чернігівської області і заходи по підвищенню їх родючості / Є.І. Бойко. – К.: Держ. видав. с.-г. літ-ри УРСР, 1963. – 150 с.
6. Бердников А.М. Зеленое удобрение – биологизация земледелия, урожай / А.М. Бердников. – Чернигов: Черниговское НПО «Элита», 1992. – 191 с.
7. Доспехов Б.А. Методика полевого опыта / Б.А. Доспехов. – М.: Агропромиздат, 1985. – 351 с.
8. Ничипорович А.А. Фотосинтез и теория получения высоких урожаев / А.А. Ничипорович. – М.: Изд-во АН СССР, 1956. – 330 с.

Анотація

Мілютенко Т.Б.

Удобрення кукурудзи на зерно при вирощуванні на дерново-підзолистому ґрунті

В умовах польового стаціонарного та лізиметричного дослідів при вирощуванні кукурудзи на зерно на дерново-підзолистому ґрунті вивчали ефективність застосування 40 т/га гною, проміжного сидерату (люпин вузьколистий), мінеральних добрив ($N_{90}P_{90}K_{90}$) та їх поєднання з сидератами. Встановлено, що органо-мінеральне удобрення сприяло формуванню найвищої в досліді урожайності кукурудзи. При цьому суттєво обмежувалися втрати сполук біогенних елементів за межі кореневмісного шару ґрунту, порівняно із використанням лише мінеральних добрив.

Ключові слова: *дерново-підзолисті ґрунти, кукурудза, сидерат, урожайність, добриво, система удобрення*

Аннотация

Милютенко Т.Б.

Удобрение кукурузы на зерно при выращивании на дерново-пдозолистой почве

В условиях полевого стационарного и лизиметрического опытов при выращивании кукурузы на зерно на дерново-подзолистых почвах изучали эффективность применения 40 т/га навоза, промежуточного сидерата (люпин узколистый), минеральных удобрений ($N_{90}P_{90}K_{90}$) и их совместное применение. Установлено, что применение органоминерального удобрения благоприятствовало формированию наивысшей урожайности кукурузы в опыте. При этом значительно ограничивались потери соединений биогенных элементов из корнеобитаемого слоя почвы по сравнению с применением только минеральных удобрений.

Ключевые слова: *дерново-подзолистые почвы, кукуруза, сидерат, урожайность, удобрение, система удобрения*